

# Estimating $N_{\text{part}}$ , $N_{\text{coll}}$ etc. using probabilistic “Glauber” models

## Overview and Philosophy

Mark D. Baker

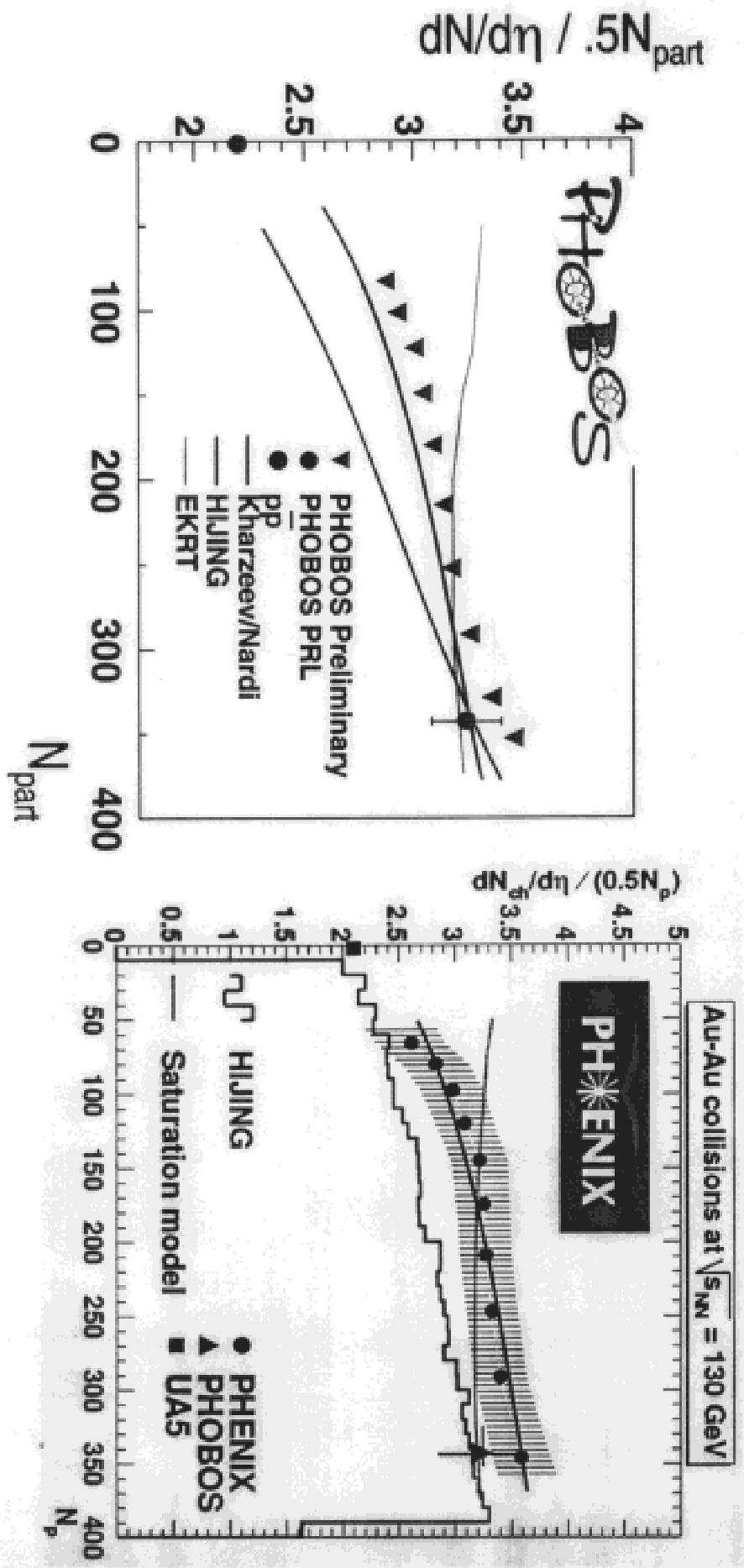
Brookhaven National Laboratory

Why should experimentalists  
“report something that we don’t measure”?

# Measurement / Theory Gap

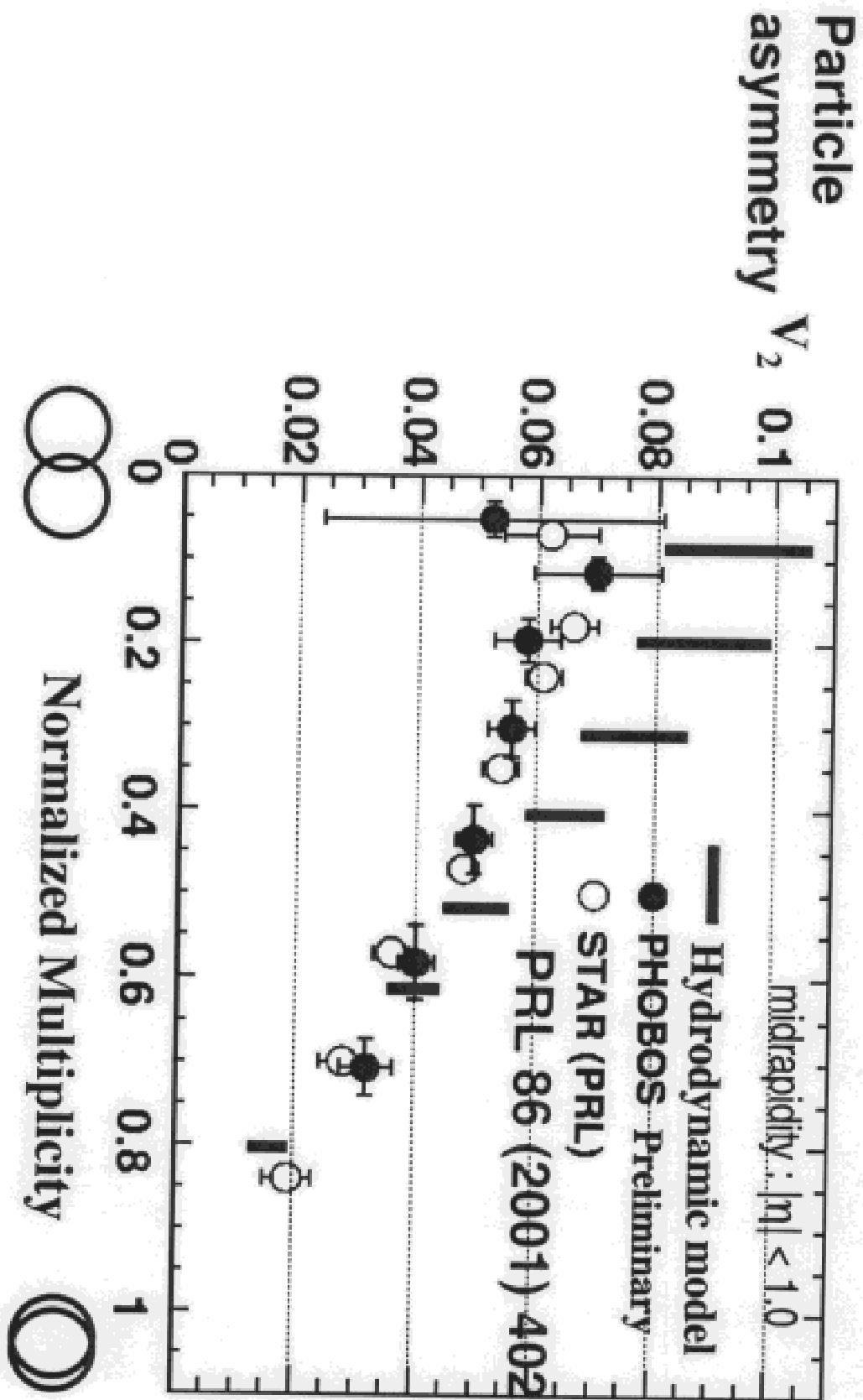
- We measure
  - # of particles,  $E_T$ , % of cross section...
- The essential physics involves
  - $N_{\text{part}}$ ,  $N_{\text{coll}}$ ,  $\epsilon_{\text{initial}}$ ,  $b$  etc.
- Bridge that gap or give up physics!
  - Estimate systematic errors on the physics.

# dN/d $\eta$ vs Centrality at $\eta=0$



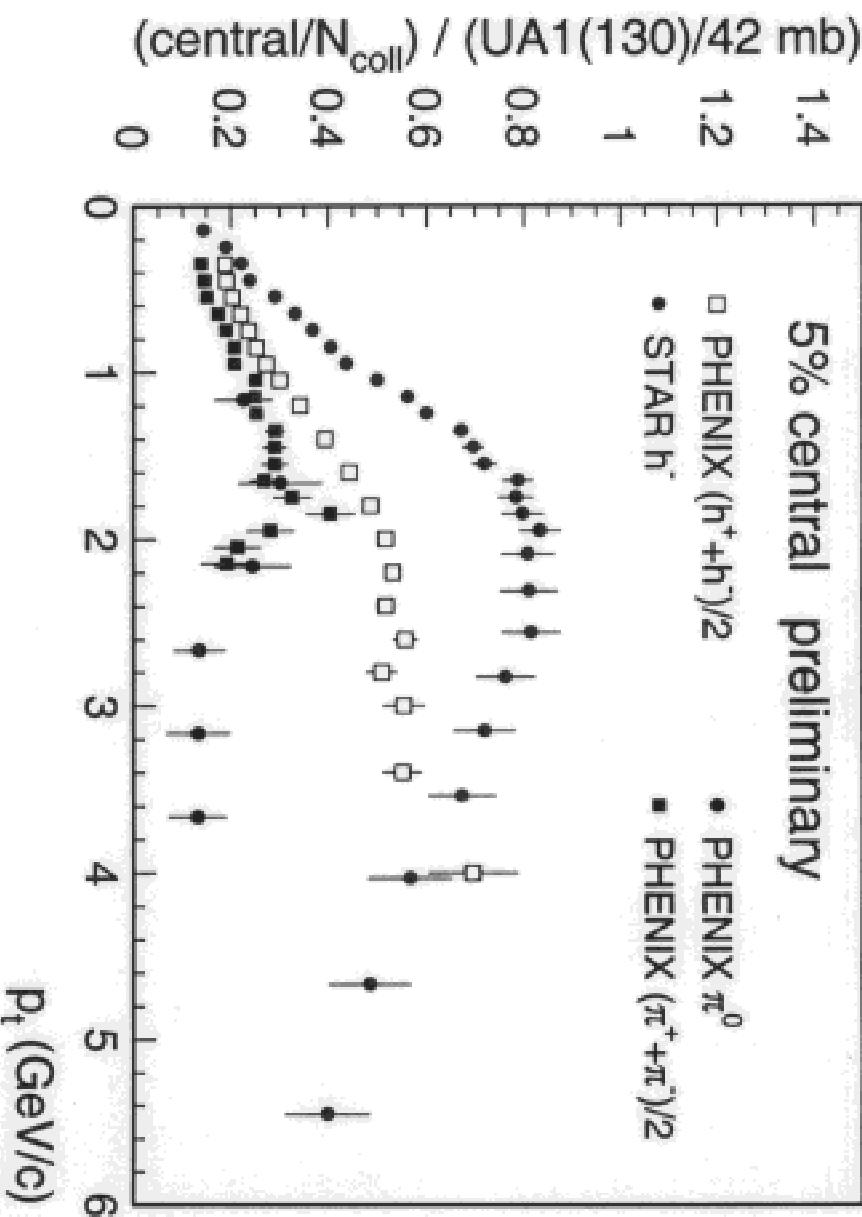
QM01, stolen from Steinberg's review talk

# Elliptic Flow (& HBT vs $\phi$ )



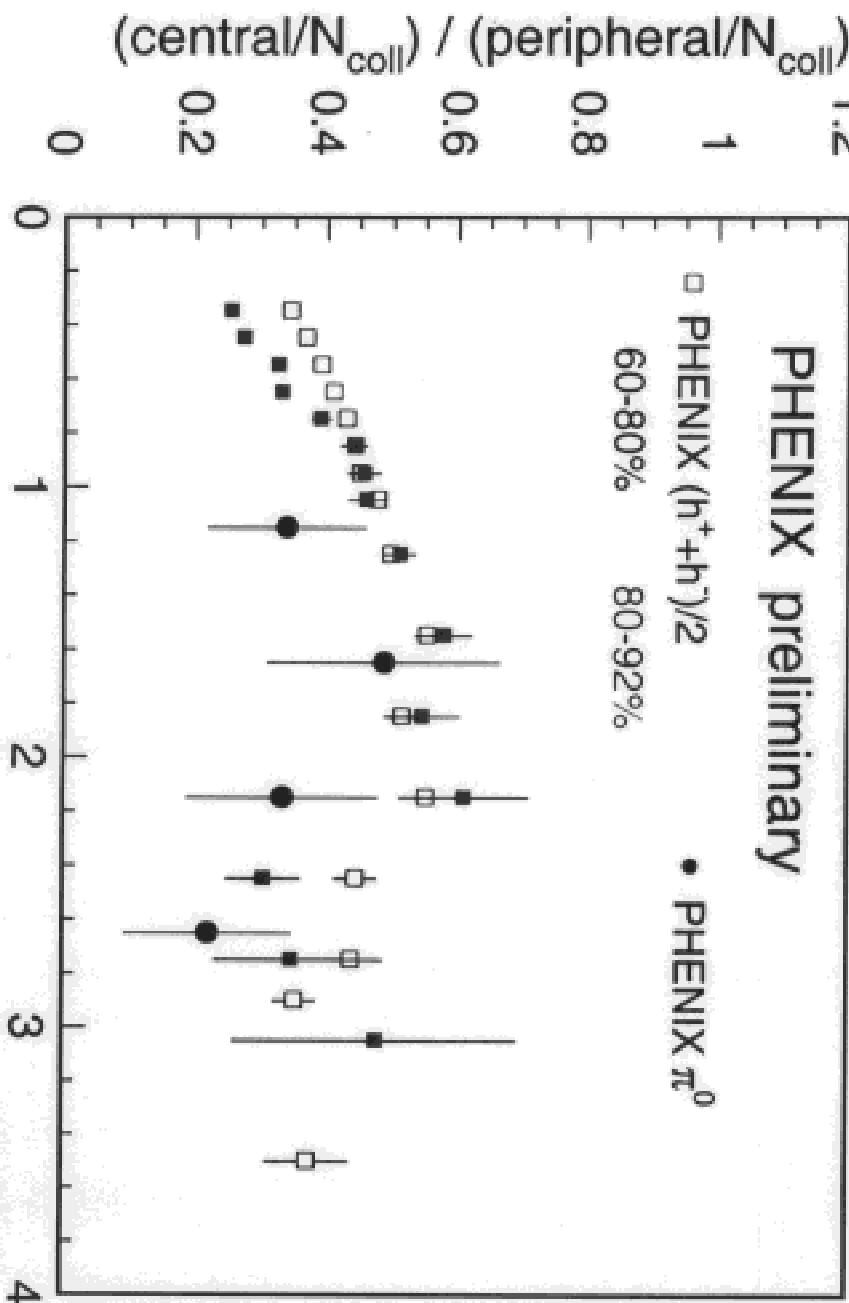
# Jet Quenching (I)

QM01, stolen from Axel Drees's review talk



# Jet Quenching (II)

QM01, stolen from Axel Drees's review talk



# J/ $\psi$ suppression

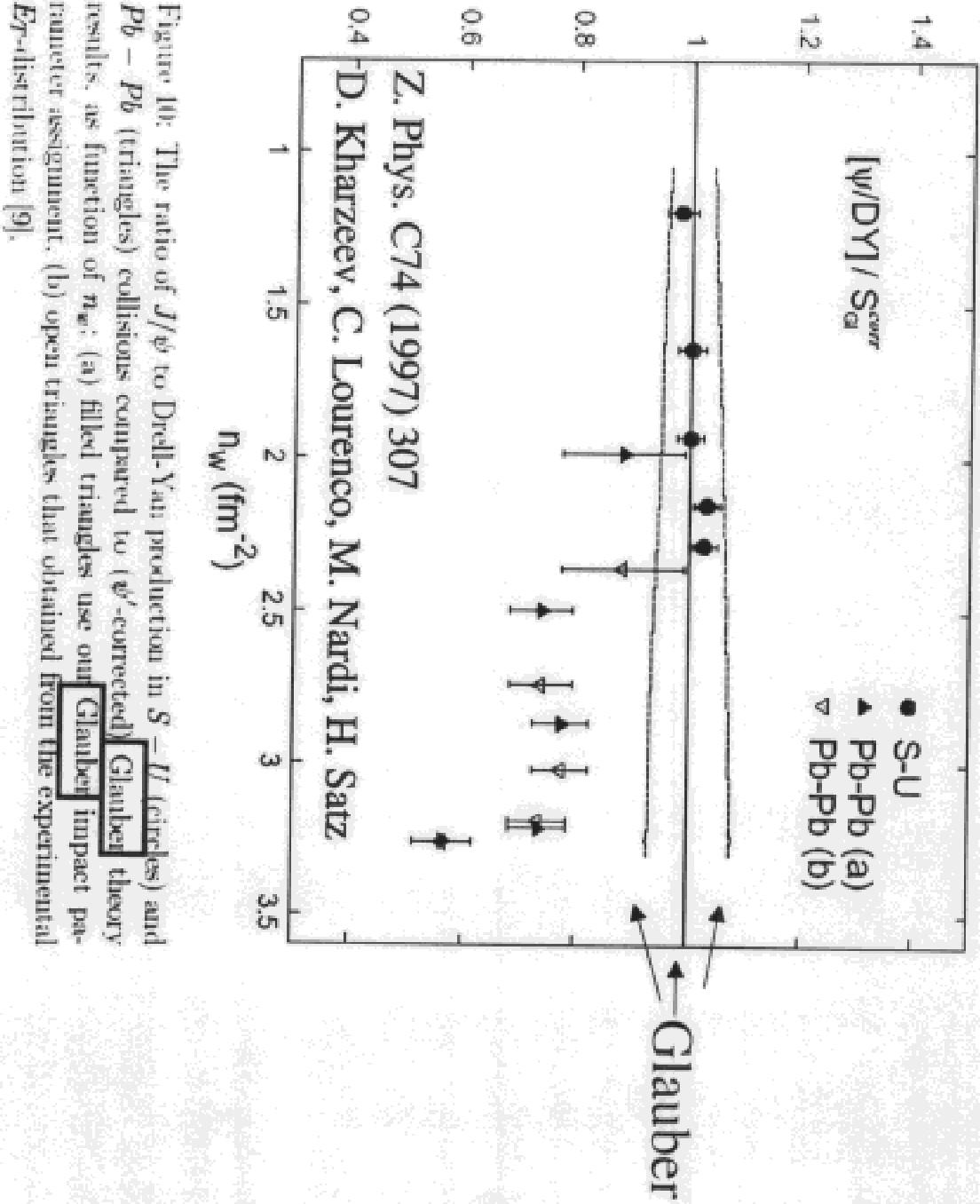


Figure 10: The ratio of  $J/\psi$  to Drell-Yan production in  $S - U$  (circles) and  $Pb - Pb$  (triangles) collisions compared to ( $\psi'$ -corrected) Glauber theory results, as function of  $n_w$ : (a) filled triangles use our Glauber impact parameter assignment, (b) open triangles that obtained from the experimental  $E_T$ -distribution [9].

# The Goal & Spirit

- Assume that we want to make centrality measurements and do the best job we can.
- Pool our knowledge
- Remove trivial differences/mistakes.
- Clarify any fundamental disagreements.
- Estimate the systematic limits on:
  - $N_{\text{part}}$ ,  $N_{\text{coll}}$ ,  $\varepsilon$ ,  $b$  estimation for data sets/bins

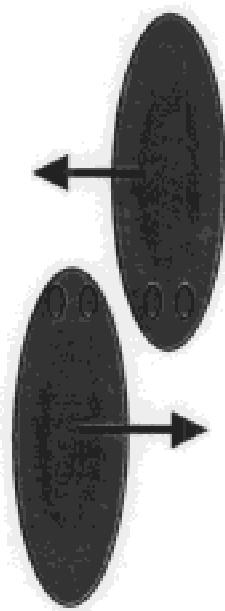
# We want to understand...

- The underlying theory & it's limits
  - Kharzeev, Steinberg, Heinz, Stankus
- The ZDCs
  - Chiu
- Cross-section measurement(s) and plans
  - Chiu, Drees, Baltz
- What the experiments do & plan to do.
  - Morrison, Decowski, Ito, Miller

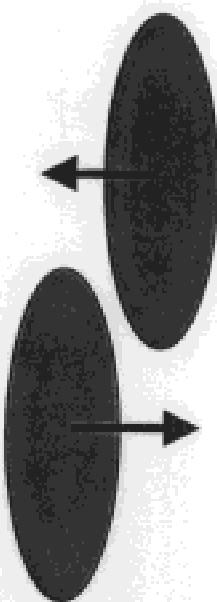
# Careful w/ the optical approximation

Full Glauber formalism

(or MC)



versus



Optical approximation

$$1 - \int \int \dots \int \int \left( \prod_{i=1}^A \prod_{j=1}^B (1 - \text{collision}_{ij}) \right)$$

↑  
A\*B terms

(A+B) 2D integrals

See Steinberg & Kharzeev

$$= \int d^2\zeta_1^{\alpha} d^2\zeta_2^A d^2\zeta_1^B d^2\zeta_2^C T_A(\zeta_1^{\alpha}) T_B(\zeta_2^A) T_C(\zeta_2^B) \partial_m$$

$$\delta^{(12)}(\zeta_1^A - \zeta_1^B + b) \delta^{(12)}(\zeta_2^A - \zeta_2^B + b) \delta^{(12)}(\zeta_1^{\alpha} - \zeta_2^{\alpha}) (\eta_{\alpha}^{\beta} - \eta_{\alpha}^{\gamma})$$

$$= \int d^2\zeta_1^{\alpha} d^2\zeta_2^A T_A(\zeta_1^{\alpha}) T_B(\zeta_2^A) T_B(\zeta_2^B) T_C(\zeta_2^B) \sigma_m$$

$$\delta^{(12)}(\zeta_1^{\alpha} - \zeta_2^{\alpha}) \delta^{(12)}(\zeta_1^A - \zeta_2^A) = \infty$$

~~one~~

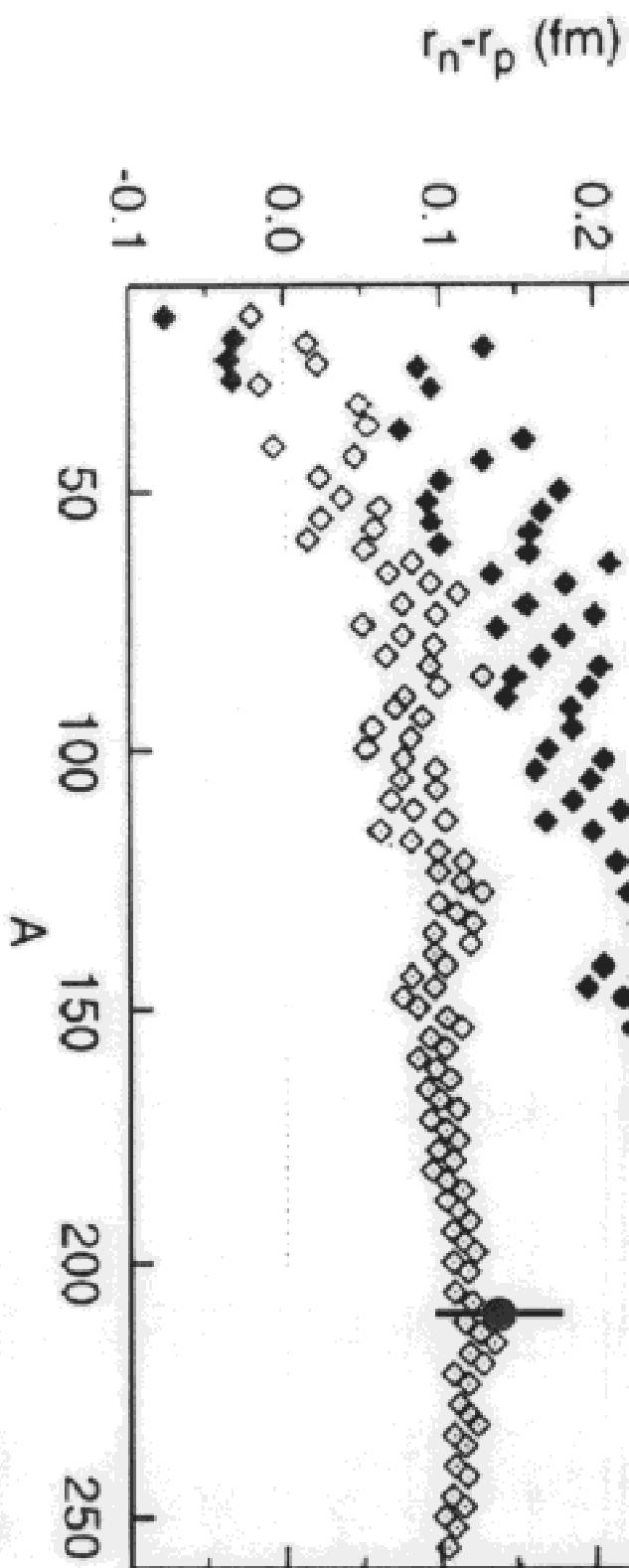
$$\mathcal{O}(\sigma_m^{-4}) \rightarrow \mathcal{O}\left(\sigma_m^{-4} \times \frac{R^2}{\sigma_m}\right)$$

# Use the right parameters

- See Steinberg, Kharzeev, + Morrison, Decowski, Ito, Miller
- But what about neutron skin?
  - PRC **46** (1992) 2587
  - nucl-th/9912038
  - (thanks M. Chiu!)
- What about aspherical nuclei (like Au!)

# Neutron skin

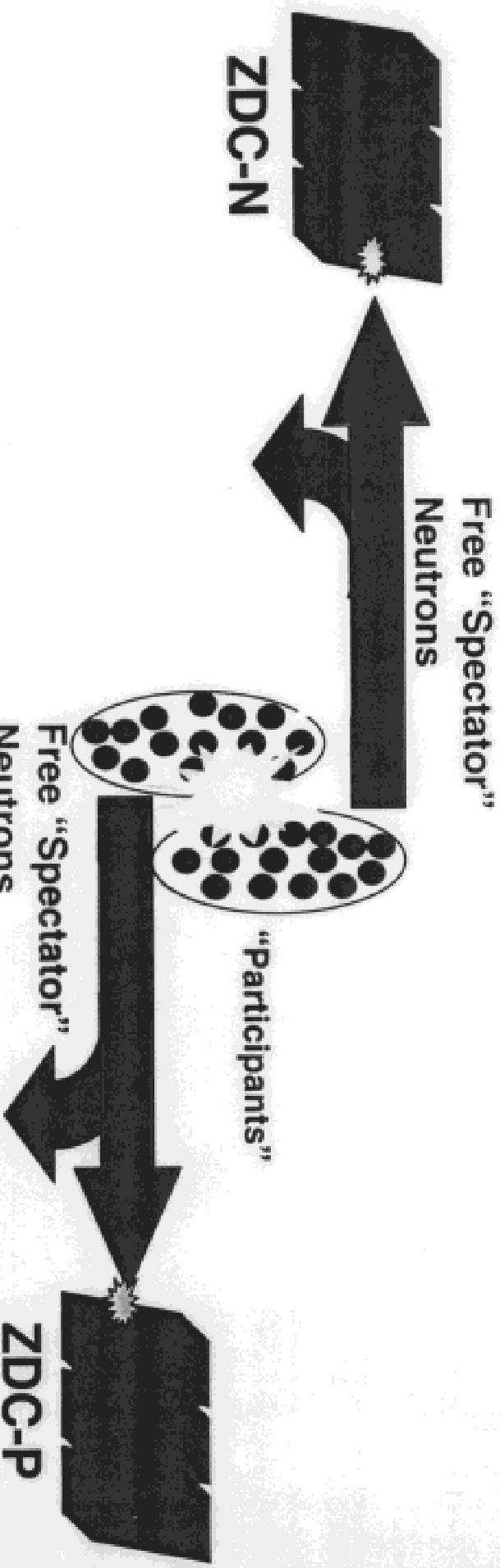
Horowitz et al. nucl-th/9912038



800 MeV  $\vec{p}$ Pb scattering, PRC 20 (1979) 2403 etc.  
But theoretical errors neglected...

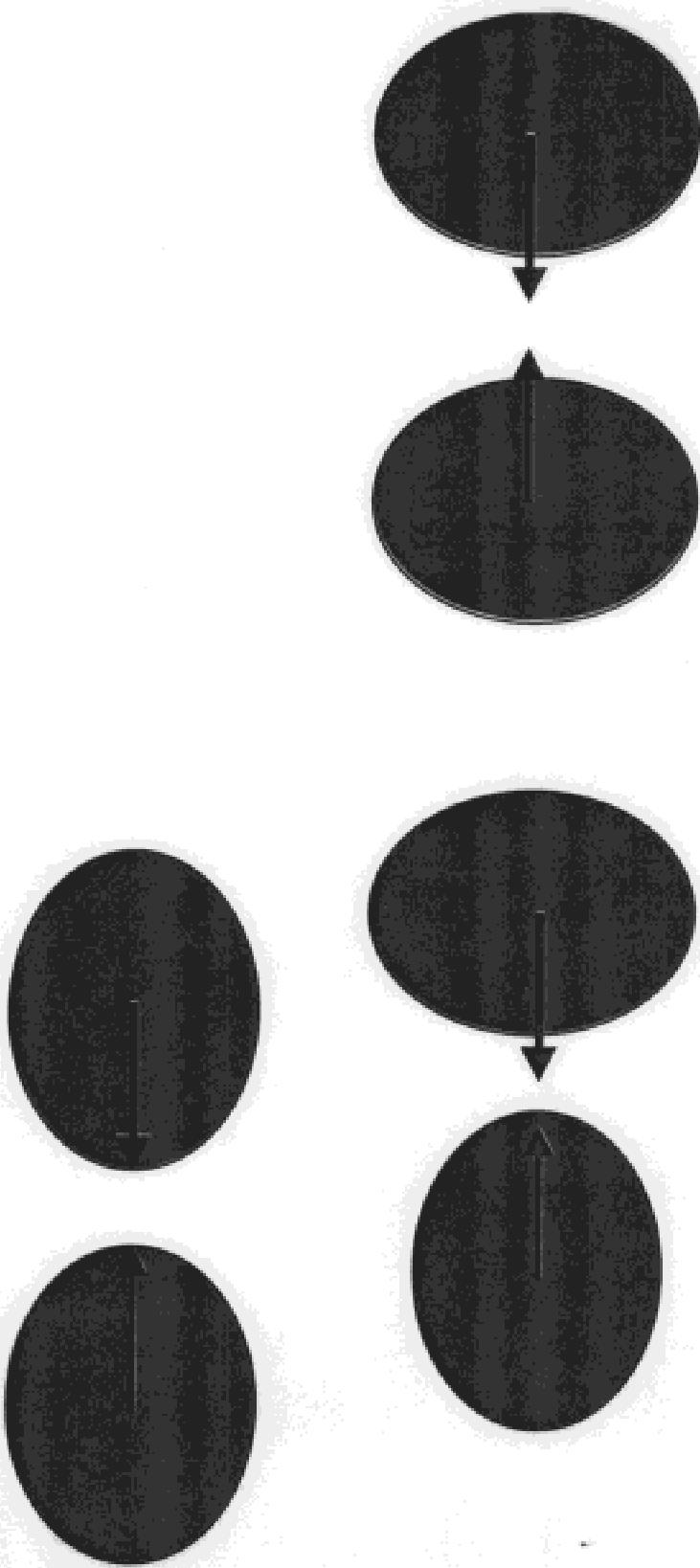
# Zero-Degree Calorimetry

- Much harder than Fixed Target!!
- Do we understand the fragmentation, even empirically?



# Aspherical Nuclei

Could modify the high  $N_{part}$  edge



# Cross-Section

- Are van der Meer scans consistent with theory and inelastic/total ratio from ZDCs?
- What are the systematic errors on the scans?
- How can they be improved this year?

# Conclusions

**Ask me tonight!!**